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ALGAL FLORISTICS IN INDIA—A RESUME

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The first record of any study of algae in India is that of John Gerard Koenig who visited this country in 1768 as a member of the Morivian Mission and collected a number of algae from Tranquebar, South India, which were later described by William Jones (1798) and other workers.

During the 19th century, there was a spurt in the study of Indian algae when almost all the contributors except Kirtikar (1886) were Europeans. The important workers of this period were Roxburgh (1832), Belanger and Bory (1836), Grant (1842), Griffith (1844), Montagne (1849), Bills (1850), Wallich (1860), Hobson (1863), Carter, H. J. (1871), Cunningham (1880), Dickie (1882), Cleve (1883), Martens (1886), Lagerheim (1888), Prain (1890), W. B. Turner (1892), Beck and Zahlbruchner (1896) and Borge (1899).

The first half of the 20th century attracted a number of Indian workers towards Algae. However, important Europeans who studied the floristics of Indian Algae during this period are Barton (1901), Allen (1925), Prain (1905), Boergesen (1929, 1930, 1931, 1932 a, 1932 b, 1933), N. Carter (1926), Groves (1924), and Fritsch (1949). The important Indian contributors during this period are Iyengar (1920, 1932 a, 1932 b, 1933 a, 1933 b, 1936) and his students on green algae, Bharadwaja (1933, 1935, 1936) and his students on Blue-green Algae, Dixit (1936, 1937), Biswas (1926, 1934, 1936, 1937, 1945, 1949), Randhawa (1936 a, 1936 b, 1937, 1939, 1941, 1942), C. B. Rao (1936), C. S. Rao (1940) and R. N. Singh (1938, 1939) on diverse groups of fresh-water algae from various parts of this country.

During the nineteenth century a number of expeditions were undertaken with the purpose of studying the Marine Algal Flora of India.

Important among them are :

1. Galathea Expedition (1845-1847) to the Nicobar Islands.
2. Novara Expedition (1857-1859) to the Nicobar Islands.
3. Preussische Expedition (1859-1863) to some of the important Indian coasts.
4. Investigator Expedition (1890-1892) to the Bay of Bengal.
5. Valdivia Expedition (1898-1899) to the Nicobar Islands and the Bay of Bengal.
6. Siboga Expedition (1899-1900) to Nicobar Islands and the Indian coasts.

In the earlier part of the twentieth century Sea Lark Expedition (1904-1905) to the Maldives and Laccadives, Yale North Indian Expedition (1932) to Ladakh and John Murray Expedition (1933-1934) to Maldives are the notable efforts.

It is evident that although a number of expeditions were undertaken, they were all centred around the study of marine algal vegetation and only one expedition, the Yale North Indian Expedition, aimed at a study of fresh water or terrestrial algae of high altitudes.

In dealing with the floristic patterns and distribution of various algal groups, it is necessary to record them in conformity to their habitats.

The habitat-wise grouping of algae broadly consists of : Fresh-water forms, High altitude forms, Marine forms, Crop-field forms, 'Usar' soil forms and Thermal Spring forms.

Fresh Water Forms : Considerable work has been done by Iyengar (1920, 1932 b, 1933 a, 1936, 1970, 1971), Biswas (1926-1937), Bharadwaja (1933-1963), R. N. Singh (1938) and Randhawa (1936 a-1959) in recording the algal flora of such habitats from East, South and Central India. If we consider the distribution pattern of such forms in various parts of India it is revealed that considerable work has been done by Iyengar (1920, 1925, 1932 a & b, 1933 a & b, 1936, 1970, 1971) in the orders Volvocales, Chlorococcales and Ulotrichales from South India. Biswas also did (1926, 1934, 1936, 1937, 1949) an extensive study to work out the Algal flora of east India, Sarma and Shyam (1974 b), described a new genus *Lundiella* from Varanasi and Patel (1967) studied Volvocalean flora of Gujarat. Phillipose (1967) described 48 genera and 160 species of the order Chlorococcales from India while Srivastava and Nizam (1969) described a new genus *Suxenella* from Andhra Pradesh and Prasad and Mehrotra (1977 a) described the genus *Quadrigula* from Lucknow, Uttar Pradesh for the first time from India. Not much work, has been done on the orders Ulotrichales and Cladophorales, besides, Ramanathan (1964) giving a biographic account of Ulotrichalean forms from various parts of India. Prasad and Jain (1973) described *Basicladia crassa* from Uttar Pradesh for the first time from India, while P. Sarma (1971) described *Cladophorella* from West Bengal. Prasad and Jain (1978) recorded *Pithophora mooreana* and *P. sumatrana* and various other taxa of Cladophorales for the first time from India. *Draparnaldiopsis indica* was described by Bharadwaja (1933) for the first time while *Fritschiella* was described by Iyengar (1933 a). Saxena (1962 a) surveyed the distribution of various members of Chaetophorales in India, besides Randhawa and Venkataraman (1962), Sinha and Das (1963-1964) worked out a few forms of this order from Bihar. Prasad and his students are doing an extensive exploratory work in the order Chaetophorales and have added *Coleochaete nitellarum* (Prasad and Srivastava 1965 c) and two new taxa of *Coleochaete* (Prasad & Asthana 1977) as well as the genera, *Chaetopeltis, Spongioplastidum* and *Chlorotylinum* (Prasad and Asthana 1975 a, 1975 b, 1976 a) to the Indian flora. Considerable work has been done in the order Oedogoniales. R. N. Singh (1938) described the members from Uttar Pradesh, Randhawa (1942) from Himalayas, Venkataraman and Natarajan (1960) from Kerala, Goel (1964 b) from Rajasthan, Gonzalves and Sonnad (1961) from Karnataka, Gonzalves and Jain (1968, 1970) from Maharashtra and Subbaraju (1968) from Andhra Pradesh. These workers have given an account of both fresh water and terrestrial forms. The order conjugales was well documented by Randhawa (1959) who described 9 genera and 74 species from various parts of India in a monograph. About 100 species have been added after the publication of his monograph mainly from Punjab, Uttar Pradesh and Gujarat. The main contribution are Rattan (1964, 1968) from Punjab, Prasad and Dutta (1970 a, 1970 b), Prasad and Jain (1977) from Uttar Pradesh and Patel and Ashok Kumar (1971, 1973, 1975, 1977) from Gujarat. Considerable work has also been done on the Desmids from India. Besides the classical work of Turner (1892) covering mainly the Eastern part of India, the important contributors are of Bruhl and Biswas (1926) from Manipur, Biswas (1934) from Assam, Kamat (1963, 1964, 1967) mainly from Rajasthan and Maharashtra, Bharati (1965, 1966) and Bharati and Pai (1972 a, 1972 b) from Karnataka, Sinha and Mishra (1967) from Bihar, Iyengar and Vimla Bai (1941) from Kodai-Kanal, South India, Suxena and Venkateswarlu (1966 a, 1966 b, 1968 a, 1968 b) from Andhra Pradesh and Kashmir, Agarkar (1969, 1971) and Agarker and Agarkar (1972, 1977) from Madhya Pradesh, K. P. Singh (1960, 1961) from Kumaon region of Uttar Pradesh. Prasad and Mehrotra (1977 b, 1977 h) gave an account of the desmid flora of some North Indian paddy fields describing 101 taxa. Fresh water Siphonales are insignificantly represented in India. The order Charales has been exhaustively treated by Pal *et al.* (1962) in a monograph describing 5 genera and 59 species from Indian region. Since its publication, not much work has been added. Vaidya and Gonzalves (1963) worked out members of Charales from Western India and Sinha and Choudhury (1969-70) gave a list from Bihar.

Both fresh-water and terrestrial members of Cyanophyceae have been well documented from various parts of India by Desikachary (1959). His monograph includes 81 genera and 493 species from Indian territory. Since its publication considerable work has been carried out by many workers from various parts of India. The important contributions amongst these are by Prasad (1962, 1964-65), Prasad and Srivastava (1964 a 1965 b), Talpasayi (1962), Pandey (1965), Pandey and Mitra (1965) and Khan (1970 b) from Uttar Pradesh. The Cyanophycean flora of Rajasthan has not received much attention and only a handful reports are available (Gupta and Kumar, 1968, Goyal, 1964 a and Vaidya, 1968). Kamat (1963) has recorded some forms from Maharashtra and Gupte (1964) from Gujarat. Vasishta (1960, 1963) from Punjab, Subba Raju (1963) from Kashmir and Srivastava (1967) from Central Himalayas have also reported some taxa. Srinivasan (1963) and Gonzalves and Kamat (1958, 1960) from Karnataka (Mysore), Subba Raju (1967) from Andhra Pradesh. Bendre and Agarkar (1965) from Madhya Pradesh and Bharadwaja (1963) from Manipur have made similar contributions.

The fresh-water Xanthophyceae, Chrysophyceae, Dinophyceae and Euglenineae have not received due attention by Indian workers so far. Fresh-water, Bacillariophyceae have been investigated in some detail by a few workers. Venkatraman (1961) published a monograph on Vaucheriaceae and described 4 genera comprising of 58 species of which only 2 genera with 8 taxa were described from India. Since the publication of this monograph, new records by Suxena (1962 b), Patel and Francis (1968) and Prasad and Saxena (1977) have increased the number of taxa of *Vaucheria* in India to 18. Apart from Vaucheriaceae, other important contributions on Xanthophyceae are those by Iyengar (1925) who described ***Botrydium*** and Prasad and Srivastava (1963, 1964 b) who added the genera ***Heterothrix*** and ***Botrydiopsis*** to the Indian flora. Prasad and Mehrotra (1970) described two species of

Tribonema from Kashmir and Kulu valley in Himachal Pradesh and Khan (1971) added *Bumelleria*. Turner (1892) described a few forms of Chrysophyceae from Eastern India while Bharadwaja (1936) was the first to report *Hydrurus* from Kashmir which was also collected later by Prasad from Kulu Valley in Himachal Pradesh and later, *Chrysodictyon* was also described. The reports on the fresh water Dinophyceae are meagre and the only works in this field are by Ramanathan (1966), Kamat (1974) and Shyam and Sarma (1975). The important contribution to the study of Euglenineae in fresh water habitats are by Suxena (1955) and Kamat (1962, 1963, 1964, 1968) from Andhra Pradesh, Gujarat, Maharashtra and Karnataka respectively.

Fresh water Bacillariophyceae have received attention in the States of Rajasthan, Gujarat, Maharashtra and Karnataka by Gandhi (1955, 1961, 1966), in Uttar Pradesh by C. S. Singh (1961) and Ahmad (1972) and in Assam by Biswas (1937). Prasad and Yashpal Singh (Unpub.) are studying the diatom flora of Northern India.

The fresh water Rhodophyceae have not dealt with extensively and only a few reports are available notably those by Misra and Dey (1959), Das (1963), Patel (1970) and Khan (1970 a).

Although considerable information has accumulated concerning fresh water aquatic algae there is still considerable scope for further exploratory studies particularly in Bihar, Orissa, Kerala, Tripura and Goa, where not much work has been done on the whole and fresh-water forms in particular. However, a few reports are available but extensive studies would be welcome.

Marine Forms : Marine members belonging to all classes have been described. Predominant among them being the Phaeophyceae and Rhodophyceae. The long coast line of India harbours a rich flora of tropical marine algae. Misra (1966) published a monograph on Phaeophyceae of Indian subcontinent covering India, Ceylon and Pakistan. Out of 32 genera and 93 species described by him, only 30 genera consisting of 86 species are actually reported from the Indian territory. After the publication of this monograph, workers like Chauhan and Thivy (1965), Srinivasan (1966), Gopalakrishnan (1969) and Rao, U. M. and Sreeramula (1970) have added numerous taxa from the Southern and Western coasts by India.

No monographic account is available for Rhodophyceae in India but Boergesen in a number of publications (1929-1933) described the algal flora of Western coasts of India chiefly concentrating on Rhodophyceae which were also later on published in a list form by Dixit (1964, 1968, 1970). Other contributions have mainly come from Balakrishnan (1961, 1962), Ganesan (1963, 1965), Krishnamurthy (1966), Krishnamurthy and Thomas (1977), Gopalakrishnan (1969), Rao, U. M. and Sreeramula (1970).

In chlorophyceae, the Siphonales are commonly found in marine habitats. No exclusive work is available and most of the work described earlier contain scattered information on this group. The marine Cyanophyceae have been worked out by Iyengar and Desikachary (1944) from South Indian coast, Venkatraman (1957) from Southern coast and Chacko (1950) from Krusadai Island, apart from other scattered works.

In Euglenineae a new marine genus *Protoeuglena* was described by Subhramanyan (1954) besides his other valuable contribution towards the marine Dinophycean flora (1966, 1968). He (1962) also described a new member of marine Chrysophyceae.

The work on marine Bacillariophyceae of Indian coastal waters has chiefly been done by Venkataraman (1939), Subramanyan (1946, 1958), Gopalakrishnan (1972) and Gandhi

(1962) around Southern and Western coast of India.

Crop-field Forms : Ever since the potential capacity of Cyanophyceae to fix atmospheric nitrogen came to light, many workers were attracted to this aspect of Phycology and started screening crop-field algal taxa, particularly those found in water-logged paddy fields. The important workers among them were R. N. Singh (1939, 1961), De (1939), Subramanyan and Sahay (1964) and Pattnaik (1966). Gradually the attention of workers shifted from paddy to other crop-fields as well and Mitra (1951 a & b) studied the algal flora of some wheat fields and Gonzalves and Yalavigi (1959) studied the algal flora of wheat, cotton and 'Jowar' rhizospheres. Dutta and Venkataraman (1958) and R. N. Singh (1950, 1961) also made ecological and taxonomic investigations on algal flora of certain crop fields. Bharati and Pai (1972 b) described some members of Oedogoniales from some brinjal fields of Karnataka (Mysore).

Prasad and Mehrotra (1977 a-h) and Prasad, Mehrotra and Singh (1976, 1977 a, b) have described over 300 taxa, including fifty four new taxa belonging to groups Cyanophyceae and Desmidiaceae from sixteen different types of crop-fields of Northern India.

High Altitude Forms : Only a few workers (Dutta *et al.* 1973, 1974, 1976 ; Suxena and Venkateswarlu 1968 c, Suxena *et al.* 1972) have attempted to study the high altitude forms in this country. The chief classes of algae represented in the high altitude flora are the Cyanophyceae and the Bacillariophyceae with a preponderance of Bacillariophyceae.

'Usar' Soil Forms : Singh (1950) emphasized the role of algae in the reclamation of large tracts of 'Usar' lands in India. Prasad and Srivastava (1968) have enumerated forty-six taxa of Blue-green algae from alkaline (Usar) soils only. No further attempt seems to have been made to study the algal flora of Usar soils.

Thermal Spring Forms : The noteworthy contributions in this field are by Gonzalves (1947), Money and John (1963), Prasad and Srivastava (1965 a), Thomas and Gonzalves (1965 a-g), Vasishta (1968), and Patel (1974). Most of the above workers recorded only Cyanophyceae but Thomas and Gonzalves (1965 a-g) have given an account of the diatoms of such habitats also.

IMPORTANT RESEARCH CENTRES & THEIR FLORISTIC CONTRIBUTIONS

During the last 50 years or so, research on Algology in the country has progressed vigorously. In early thirties Y. Bharadwaja and M. O. P. Iyengar returned to India after their training under Prof. F. E. Fritsch and established strong Schools of Algae at Varanasi and Madras respectively. Bharadwaja (1933, 1935, 1936, 1963) and his students concentrated on Blue-green algae while Iyengar (1920, 1932 a, 1932 b, 1933 a, 1933 b, 1936, 1970, 1971) devoted himself to the Green Algae. Their students, notably R. N. Singh (1938, 1939, 1947, 1950, 1954, 1961), T. V. Desikachary (1948-1962) and K. R. Ramanathan (1964, 1966, 1968) carried on the good work and the traditions were maintained. Quite independently, M. R. Suxena, another student of Fritsch, established a third centre of Algology at Osmania University, Hyderabad in the late forties and developed aspects of Hydrobiology, in addition to systematics of algae. With his student V. Venkateswarlu (1966 a, 1966 b ; 1968 a, 1968 b, 1968 c) he has published well illustrated accounts of Desmidiaceae from various parts of India. While M. S. Randhawa (1936 a, 1936 b ; 1937, 1939, 1941, 1942, 1959, 1962) made contributions on Oedogoniales, Conjugales and other green and Blue-green algae.

The centre at Benaras Hindu University has maintained throughout a high tempo of work and at present Y. S. R. K. Sarma and his students (1974 a, 1974 b) are working on algal systematics and Cytology. At Madras, T. V. Desikachary (1948, 1953, 1957, 1959, 1962) concentrated on systematics and morphology of various algal groups and later, with his students, worked on experimental taxonomy of Blue-green algae. With Desikachary's recent retirement, the Madras School is left very much poorer.

Besides the two old centres of Varanasi and Madras, their students have established centres of Algological research at several places. Notable among these other centres are Lucknow, Ranchi, Allahabad and Vallabh Vidya Nagar (Gujarat). At Lucknow, B. N. Prasad (1962, 1964-65) and with his students P. N. Srivastava (1963, 1964 a, 1964 b, 1965 a, 1965 b, 1965 c, 1968), Shipra Dutta (1970 a, 1970 b), R. K. Mehrotra (1970, 1977 a, 1977 b, 1977 c, 1977 d, 1977 e, 1977 f, 1977 g, 1977 h), V. Jain (1973, 1977), M. Saxena (1977), D. K. Asthana (1975 a, 1975 b, 1976) and Yashpal Singh (1976, 1977 a, 1977 b) worked on cytology, systematics and floristics, morphology and terrestrial algae, particularly of crop-fields and alkaline (Usar) soils. At Ranchi, J. P. Sinha and his students M. C. Chowdhury (1969-70) and R. N. Das (1963-64) have added to our knowledge of the floristics of that area—mainly the green algae. At Allahabad, A. K. Mitra (1950, 1951 a, 1951 b) worked on soil algae and culture studies. Similar work is being continued by D. C. Pandey (1965) and his colleagues. At Vallabh Vidyanagar, R. J. Patel (1967, 1970, 1974) is recording the algal flora of Gujarat with considerable vigour.

Among the government Institutes carrying out algal researches, mention may be made of Central Salt and Marine Chemicals Research Institute, Bhavnagar and its Camps at Mandapam and Krusadai Islands in Tamil Nadu where floristic studies are being done by many workers. The National Environmental Engineering Research Institute at Nagpur has also done considerable work in the field of Public Health and sanitation and has contributed to the study of algae in relation to Public Health. The Botanical Survey of India, through the important works of K. S. Srinivasan (1965) and K. Biswas (1949), has rendered important service to Algology by condensing the otherwise scattered information on the distribution of algae. The seven monographs on Indian algae published by the I.C.A.R. on chlorococcales by M. T. Philipose (1967), Ulotrichales by K. R. Ramanathan (1964), Charophyta by B. P. Pal, B. C. Kundu, V. S. Sundaralingam and G. S. Venkatraman (1962), Zygnemaceae by M. S. Randhawa (1959), Vaucheriaceae by G. S. Venkatraman (1961), Phaeophyceae by J. N. Misra (1966) and Cyanophyta by T. V. Desikachary (1959) are extremely valuable steps towards the study of algal systematics. Apart from these, a number of Marine and Fisheries Research Stations in India, have studied problems connected with algae in relation to pisci-culture.

Compilation of comprehensive monographs and the revision of already existing ones is important. The need for working out the Algal flora of India is, therefore, paramount, having its own fundamental importance. So much work has been done on algae in the past two decades that a systematic rearrangement and compilation of literature are necessitated.

There are still vast areas in India, which are comparatively unexplored and very little is known about their algal floristic patterns. Information on algal classes, Xanthophyceae, Chrysophyceae, Cryptophyceae, Euglenineae, TABLE SHOWING GENERA/SPECIES RATIO AND PERCENTAGE REPRESENTATION OF VARIOUS ALGAL CLASSES IN INDIA

Class	IN WORLD	IN INDIA	Percentage Representation In India	
	Genera/species Ratio	Genera/species Ratio	Genera	Species
Chlorophyceae	1 : 14	1 : 10	39.13	27.30
Xanthophyceae	1 : 5	1 : 3	8.57	5.45
Chrysophyceae	1 : 5	1 : 2	4.66	1.41
Bacillariophyceae	1 : 32	1 : 9	35 60	9.72
Cryptophyceae	1 : 7	1 : 1	4.34	0.66
Dinophyceae	1 : 10	1 : 7	35.45	23.54
Chloromonadinae	1 : 1			
Euglenineae	1 : 18	1 : 9	16.66	8.73
Phaeophyceae	1 : 8	1 : 4	16.31	8.32
Rhodophyceae	1 : 6	1 : 2	12.82	5.15
Cyanophyceae	1 : 11	1 : 7	58.66	41.17

Phaeophyceae and Rhodophyceae is grossly inadequate while no member of Chloromonadineae has been recorded from India. The Genera/Species ratio (as shown in the table) also clearly indicates our poor knowledge upto date.

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